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Rural photovoltaic electrification program in Jordan

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Abstract

The photovoltaic (PV) technology potential for Jordan is high, based on the fact that many remote and isolated sites are located far away from the national electric grid and cannot be connected to it in the near future. Therefore, a rural PV electrification program—driven by quality-of-life improvement for the users—was launched in Jordan in 2002. An important element of the program is the access of low-income, rural consumers to essential electricity.

This paper discusses and analyses the first stage of this program that is the electrification of a remote and small Jordanian village. Nine PV solar home systems (SHS) were installed in this village in order to provide lighting and power for radio and television.

Feed back from the users of the installed systems indicates that the PV based electricity has been providing very satisfactory service to the consumers, and that it is an appropriate technology suitable for dissemination in the rural Jordanian areas.

Keywords: Rural photovoltaic electrification; Solar home system; Jordan

Contents

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1. Introduction

Rural electrification of isolated areas is a necessary condition to accomplish their socio-economical development. Unfortunately, because of some economic and technical considerations, several remote sites in Jordan are not connected to the national electric grid until now. Electricity generation units using diesel generators form the basis of energy supply systems for many remote and isolated communities [1–3]. But the utilization of diesel powered systems was combined with pollution and they needed frequent maintenance and repair. This caused interruption in operation for long periods and resulted in high costs [4].

On the other hand, many remote and isolated areas in Jordan are blessed with high potentials of solar energy [5–10]. To supply electricity with quality light, reliable service and long term sustainability, PV technology is an important emerging option [11–13]. PV systems not only would provide reliable, clean, and environment friendly energy, it could also create employment opportunities in the vicinity of its operation [14,15]. Therefore, in 2002 the Jordanian Government launched a project regarding the utilization of PV generators instead of diesel motors for the electrification of rural sites.

Fig. 1 shows the remote and isolated Jordanian villages, which were selected for PV electrification based on the following factors:

- The selected villages are not—and cannot be—supplied from the national electric grid, even in the long term.
- The selected villages are in the focus of the Jordanian Government's rural development program.
- The selected villages are blessed with high potentials of solar energy.

At the first stage of the rural PV electrification program, the target was the electrification of one site (Rawdet elnabdan village). Based on the technical results obtained, and the impact on local population, a decision will be made whether to disseminate the project in the rest sites or not.

In this paper, the first stage of the rural PV electrification program in Jordan is discussed and the model for installation and maintenance including the social impact of the new technology on the local population is analyzed.

2. PV system components and installation

The selected site for installation of the PV system—Rawdet elnabdan village—is located at 22 km away from electric grid. It contains eight households and a school with a population of about 113.

The household electricity demand of Rawdet elnabdan village was assessed by interviews with the village's inhabitants and observation. It was noted that the electrical load for one house is as follows:

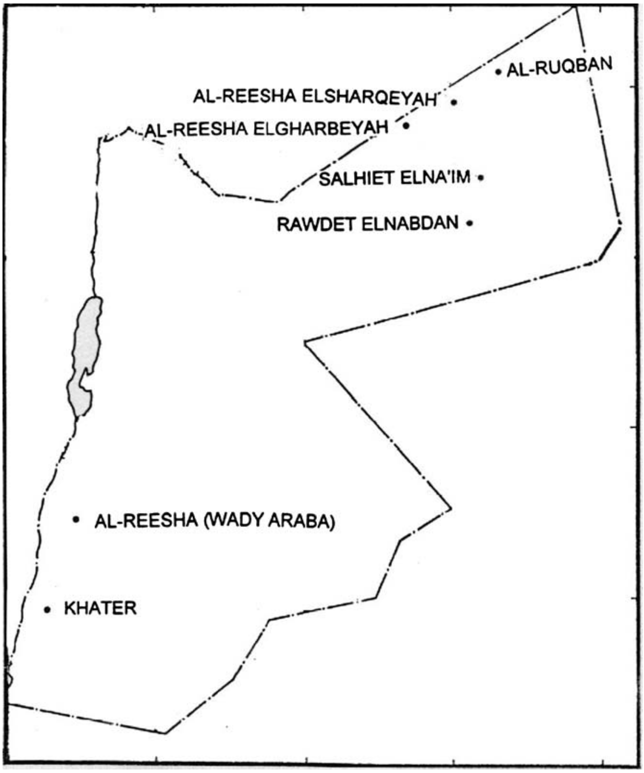


Fig. 1. Jordan map with the selected sites for the PV electrification.

- 70 W for a TV, operating for 6 h/day.
- 100 W for five energy saving lamps, operating for 8 h/day.
- 15 W for a radio, operating for 6 h/day.

Based on the fact that the households in this site are scattered, and from the economical point of view, the centralized PV system option was abandoned. It was replaced by individual SHS. The installed power for each SHS is about 400 W at 220 V and 50 Hz frequency. Fig. 2 shows a block diagram of the utilized SHS. It consists of the following components:

- The PV generator: consists of eight polycrystalline panels, with 400 W peak power. Table 1 shows the technical features of one solar panel.
- The charge controller: its technical specifications are shown in Table 2.
- The inverter: its technical features are depicted in Table 3.
- The battery bank: consists of 12 lead acid batteries for each house. Each battery has a voltage of 2 V, and a capacity of 323 A h. The total capacity of battery bank (12 batteries) for each house is 7.75 kW h.

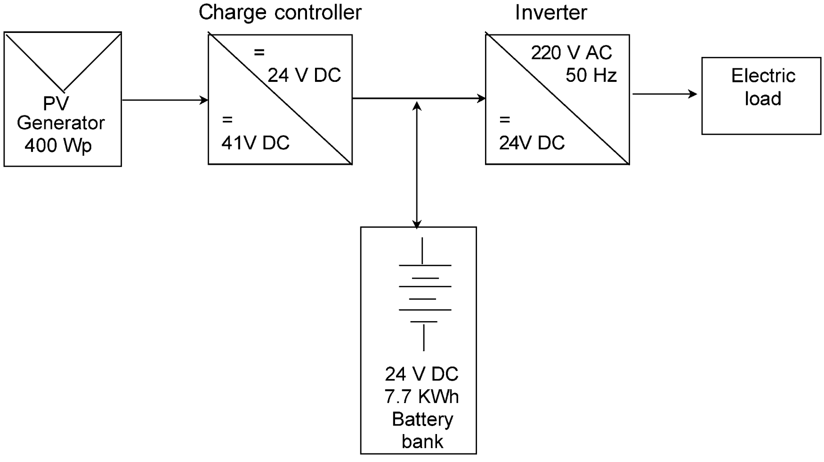


Fig. 2. Block diagram of the utilized PV system.

Table 1
Technical features of one solar panel of the installed PV generator

Open circuit voltage (V_{oc})	21.9 V
Short circuit current (I_{sc})	3.3 A
Current at peak power (I_{mpp})	3 A
Voltage at peak power (V_{mpp})	17.3 V
Peak power (P_{max})	52 W
DC voltage (V_{dc})	220 V

Table 2
The charge controller's technical features

Input voltage (V_{in})	8–50 V
Maximum input current (I_{in})	30 A
Output voltage (V_{out})	22–28.6 V
Peak power (P_{max})	720 W

Table 3
The inverter's technical features

Input voltage (V_{in})	24 V
Output voltage (V_{out})	220 V at 50 Hz
Peak power (P_{max})	700 W

Installation of the PV systems was carried out by the Jordanian National Energy Research Center (NERC) and accomplished in July 2002. Fig. 3 exhibits one of the village's residences with the installed SHS on its roof.

The village residents—right from the start of the installation process—showed to be very cooperative by quickly transporting the equipments, making the erection of shelters for the batteries, and preparation of the poles for securing the PV modules. On finalizing the installation process, the basic principles for maintenance of the system were presented to the village's residents.

3. SHS performance

After the SHS installation, there was a problem with only one of nine systems, which was not used for two weeks. In this system the charge controller was damaged, but it was quickly repaired.

Although initial results of the installed systems are favorable, their performance over longer periods of time is still being evaluated. Currently the systems are in perfect technical function. The only maintenance work required is filling up of distilled water in the batteries.

After installation of the system, considerable improvement was noted in the inhabitants' standards of living, and the children in their households could study at night.



Fig. 3. A household in Rawdet elnabdan village with the installed SHS on its roof.

4. Conclusions

Users' satisfaction indicates that the PV systems are capable of supplying the basic electricity needs with an acceptable level of quality. Improvement of children's education, entertainment, and information through TV and radio are the prominent effects of PV electrification in the village.

The PV systems installed in Rawdet elnabdan village demonstrated that such systems are an appropriate technology suitable for dissemination in the rural Jordanian areas for electrification, thus contributing to the rural development program of the government. However, the sustainability of a successful rural PV electrification program in Jordan depends on the adopted model and strategies. The challenge for those working with this program is identifying all the interrelated aspects of market, technical, social and economic issues, as well as building up both the government and the user confidence in this new technology.

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